University of Alberta

Monitoring and Assessing Clinical Clerkship Experience.

by

Michael Châtenay ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of

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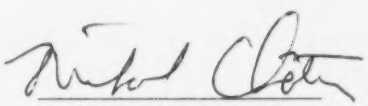

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Dedication

This work is dedicated to Sharon, Keaton and Krysten for their endless patience and support.

Abstract

Controversy persists over the educational value of the volume of student clerkship clinical activities. This thesis examines the relationship between the volume of student clerkship activities in a multi-site clerkship and the students' performance on examinations of surgical principles. The intention was to determine if: 1) student clerkship experience were similar between sites, 2) student performance on surgical examinations was similar between sites 3) experience gained from previous rotations impacted examination scores, and 4) the volume and type of experience offered during the surgical clerkship was related to the students' performance on their exit examinations.

Logbooks were used to document the clinical experiences of 109 students from the class of 1995 during a 10-week, multi-site surgical clerkship. Clinical experience and pre- and post-rotation examination performance were compared between clerkship sites as well as between rotation blocks. The influence of high versus low volume experience on student examination scores and the impact of clinical experience on the correlations between pre- and post-rotation examination performance was determined.

Marked variation in clerkship clinical experience was seen between sites. However, pre- and post-rotation scores were similar. Students with surgery as their first rotation performed less satisfactorily on the objective-structured clinical examination (OSCE). Students rotating later in the year had higher rotation evaluation scores. The volume and nature of clinical experience had no impact on rotation grade, post-rotation multiple choice, or end-of-medical school multiple choice examination scores. However, students with high volume experience in emergency admissions and feedback performed better on the OSCE. Students with high volume outpatient clinic experience performed less satisfactorily on the OSCE. Feedback increased the correlation between pre-rotation exams and the OSCE, in a negative direction for elective admissions and positively for emergency admissions.

These data suggest the need for further study. The nature of feedback and outpatient experience will have to be further examined. The logbooks used in this study have been altered to address these issues.

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List of Abbreviations

C

Comp.: phase III comprehensive examination

M

MC: Multiple Choice examination.

N

NBME: National Board of Medical Examiners

NG: nasogastric tube

O

OPD: Outpatient Clinics

OR: Operating Room

OSCE: Objective Structured Clinical Examination.

P

PAC: Pre-Admission Clinic

S

SC: Surgery Comprehensive examination.

SS: Supplemental Surgery examination

Glossary

B

Background Variables--assessment tools used to estimate the students' pre-rotation surgical knowledge.

E

Educational Experience--activities geared toward providing students with medical and clinical knowledge.

Elective Assessments--histories and physical examinations conducted on patients prior to elective surgery.

Elective Rotation--a clinical rotation the student chooses to experience, usually in an area of interest for the student.

Emergency Assessments--histories and physical examinations conducted on patients admitted for emergent surgical problems.

Experience Variable--student clinical experiences measured in this study.

F

Feedback--method of education whereby students receive information about the adequacy of their performance of clerkship duties and suggestions are made as to how to improve their performance.

K

Knowledge Gain Studies-- studies attempting to determine the benefit of clerkship experience in increasing student knowledge.

Knowledge Retention Variable--assessment tool used to estimate the students' retention of surgical principles.

L

Logbooks--manuals used by students to record clinical experience.

M

Multi-Site Clerkship--clerkship rotations where students are dispersed through more than one affiliated teaching site.

Multi-site Monitoring Studies--studies examining differences in clerkship experience between affiliated teaching hospitals.

O

Objective Structured Clinical Examination--examination involving evaluation and grading of the proficiency of students' assessment of standardized patients.

OR Scrubs--operating room procedures.

Outcome Variables--assessment tools used to estimate the students' knowledge and ability immediately after the surgery rotation.

Outpatient Clinics--clinics involved in the care of patients not admitted to hospital.

Overall Monitoring Studies--studies describing clerkship experience in terms of total number of experiences and allocation of time for various clerkship activities.

P

Patient Assessment--clerkship duty involving taking a history and performing a physical examination on patient.

Performance Variable--examinations and assessments used to estimate student surgical knowledge and ability.

Phase III Comprehensive Examination--surgery questions from the fourth year comprehensive examination.

Pre-Admission Clinic--clinics designed for expedient preoperative patient assessment days to weeks before the scheduled surgery allowing patients to be subsequently admitted the same day as their surgery.

Procedures--ward procedures observed or performed by clinical clerks such as intravenous lines, foley catheters and chest tubes.

R

Rotations--blocks of clinical clerkship time designed to expose students to the various medical disciplines.

S

Service Experience--activities performed by the student as part of the medical team to assist with patient care.

Supplemental Surgery Examination--multiple choice examination written at the conclusion of the second year surgery course.

Surgery Comprehensive Examination--surgery questions from the second year comprehensive examination.

Chapter 1

Introduction

Medical student education at the University of Alberta involves two years of pre-clinical training during which students obtain knowledge of basic and clinical science through lectures and study. This is followed by two years of clinical clerkships in the form of ward rotations and electives of varying lengths in the various medical disciplines.

The students analyzed in this thesis rotated through 12 weeks of internal medicine, 10 weeks of surgery, 8 weeks of pediatrics, 8 weeks of obstetrics and gynecology, 4 weeks of radiology, 4 weeks of family medicine and 2 weeks of anesthesiology. They were also given 14 weeks in which to pursue extra training through "electives" of the students choosing.

During rotations, students were assigned to preceptors at one of four teaching hospitals and were responsible for assessing patients (histories and physical examinations). Students were also responsible for supervised inpatient care, writing of orders and progress notes, as well as outpatient or office experience and assisting in the operating room (for the surgical specialties). During rotations, students also participated in teaching sessions and seminars, ward rounds and bedside teaching sessions. Through these activities, students are expected to acquire necessary competence in clinical assessment, diagnosis, technique and physician-patient interaction skills required of a practicing physician.

The learning experiences outlined above can be divided into two components: education and service. Educational experiences are those activities specifically directed toward providing students with medical and clinical knowledge. Service activities are those performed by the student as part of

the medical team to assist with patient care. It is assumed that students learn by participating in service activities.

Educational activities generally take the form of didactic teaching in seminars or lectures by staff and residents. Bedside teaching, "educational rounds" and feedback on the students' patient assessments also fit into this category. Thus, activities that encourage one-on-one contact with staff can be considered educational. Such environments as outpatient or office experience foster an environment where medical staff can pass their medical experience and knowledge on to the student. Educational experience activities are performed primarily for the acquisition of knowledge by the student.

Service activities are directed primarily towards patient care. Patient assessment by history and physical examination, on call duties, operating room experience, and ward procedural experience can thus be categorized as "service", although most educators would agree that by participating in these experiences, students acquire knowledge. Service experience is intended to foster ability in clinical assessment, diagnosis, patient care, procedures and patient-physician relationship all of which are not readily attainable by lecture or textbook learning.

Clerkship training in general surgery, like all medical disciplines, would seem to require student exposure to basic technical and diagnostic skills. Adequate training of surgical clerks requires close monitoring of their exposure to and proficiency in these techniques. Sufficient opportunities to practice these skills and feedback on the students' ability to perform them adequately would appear to be essential components of the surgery clerkship.

However, large numbers of medical students and diminished hospital inpatient resources have resulted in increased competition for clinical experience. This problem has been addressed by the utilization of training sites remote from the traditional university teaching hospitals. This solution posed another problem: within a given program, were the experiences offered students at these various sites uniform? If not, did differences in experience, particularly in the more technical discipline of surgery, affect student examination performance?

The use of the preceptor based model also posed a problem. Each preceptor's clinical interests and practice varies. Thus each student's experience likely varied according to the nature of their preceptor's practice. Did this disparity in clerkship experiences offered students impact student examination performance?

Despite widespread acceptance of the apprenticeship approach to clinical training, examination of clinical clerkships and the issues outlined above has led to controversy as to the educational value of clinical experience (for example Baciewicz et. al.[1], Gary and Rosevear[2], Stillman[3]). Do students acquire necessary skill and knowledge during their rotations? In what format is clinical exposure beneficial to the students? Twenty-five years ago, there was little documentation of the content of the rotations. With the advent of various experience monitoring tools, questions began to be answered about the nature of clinical clerkship experience and its benefit for furthering medical student knowledge.

Purpose of Thesis

Previous research into monitoring and assessing clerkship experience has focused on determining: 1) quantity of experience both in terms of numbers of experiences and time allocated to each category of experience (for example, La Palio[4]), 2) similarities or differences in clerkship experiences at multiple sites (for example, Gordon et. al.[5] and Friedman et. al.[6]), 3) the educational impact of select aspects of or modifications to an existing clerkship (for example, Garrard and Verby[7] and Ende et. al.[8]), and 4) the impact of rotations on examination marks (for example, Stillman[3]).

Study results have been contradictory. Some have shown similarity in experience between sites (for example, Gordon et. al.[5]). Others have shown variation (for example, Friedman et. al. [6]). Some have shown an educational benefit of clerkship rotations (for example, Stillman[3]); others have not (for example, Gary and Rosevear[2]). However, no studies have attempted to determine the educational benefit of the various clerkship experiences offered during a rotation.

This thesis addresses the nature of the surgery clerkship at the University of Alberta. More specifically, experience logbooks and several pre-rotation and post-rotation student assessments were used to determine if: 1) student clerkship experience were similar between sites, 2) student performance on surgical examinations was similar between teaching sites, 3) experience gained from previous rotations impacted on examination performance, and 4) the volume and type of experience offered during the surgical clerkship was related to the students' performance on their exit examinations.

The contents of this thesis follow. Chapter 2 provides a comprehensive review of the studies that have been done in this area. Chapter 3 details the methods used for this study including a description of the surgical clerkship, experience logbooks, surgical examinations and data analysis. Chapter 4 outlines the results of the study and Chapter 5 discusses these results. Several questions remain unanswered by this thesis, prompting the need for further study. These unanswered questions are presented in Chapter 6.

Chapter 2

Literature Review

Chapter 1 consists of 6 sections. The first section outlines the various methods that have been used to monitor clerkship experience. These methods have been used in various types of studies. Sections 2 through 6 will review the papers dealing with these types of studies.

Monitoring Clerkship Experience

The following methods have been used to quantify student clinical experience.

1. estimation by looking at hospital demographics
2. questionnaire
3. logbook or diary
4. trained observers

Studies using these techniques have concentrated on the areas outlined in Table 2-1.

Table 2-1 - Description of Types of Clerkship Monitoring Studies.

Study Type	Purpose
Experience Study	
Overall	Examine overall clinical experience at traditional clerkship sites.
Multi-site	Explore differences in experience between multi-site clerkship locations.
Non-traditional sites	Define rural or outpatient/office clerkship experience.
Knowledge Gain Study	Document the improvement of student examination performance from the beginning to the end of the rotation.

Studies Documenting Overall Clerkship Experience

Several studies have described clinical clerkship experience both in terms of total numbers of experiences and allocation of time for the various activities.

La Palio (1981) had four medical students document in logbooks the amount of time they spent performing various clinical activities during a one week period of an internal medicine clerkship.[4] Using a questionnaire, he collected data from medical staff. The questionnaire was designed to estimate the staff's perception of how much time should be allocated to the various activities and how much time staff perceived the student to be spending at the activities. Comparison of experience logged by the students with staff perception of time allocation revealed that faculty members overestimated time spent on service and underestimated time spent on educational activities. Comparison of logged activities with the amount of time the staff desired allocated to these experiences, revealed that staff felt students should be spending less time on educational activities and more time caring for patients and doing procedures.

Expanding on his initial work, La Palio et. al. (1983) utilized trained observers and logbooks to document time spent at various activities. The observers followed three students in the hospital on six consecutive days during a six week clerkship rotation and recorded information about student clerkship activities during these periods.[9] The authors then combined experience data recorded by the students in the logbooks with experience data recorded by the observers to determine the nature of the clerkship. They found that students spent 12-14 hours per day at the hospital. Of this time, 29 to 36% was spent in formal learning experiences, 22 to 25% was direct patient contact and 18 to 25% of the time was spent doing chart work. Twenty-five percent of the time was spent pursuing independent study, sleeping, performing ancillary services, call work or other activities. This did not include additional research and studying the student have done at home. Second, they found that active involvement of the students in the daily responsibility for patient management was minimal, but their involvement in daily patient care was quite high. Finally, the students relied heavily on residents and interns for their instructional activity.

With respect to the nature of clerkship experience, La Palio and his colleagues brought to light the excessive one hundred hour work weeks spent by some of the trainees as well as the occasional period where a student spent 32 hours on duty with very little sleep.[4] They stated that information obtained from using the logbooks could lead to improving education by restructuring the schedule of daily activities. With the additional information provided by observations and interviews, strategies could be implemented for improving the quality of the learning experiences.[9]

Links et. al. (1988) used logbooks to document the clinical experiences of 25 students during their psychiatry rotation.[10] They identified areas of deficiency in the clinical clerkship as it was currently formatted. Their specific areas of concern were insufficient student exposure to several common psychiatric problems such as pediatric psychiatry, delirium and anorexia nervosa.

Schamroth et. al. demonstrated the utility of patient encounter logs to document the activities of 48 students during their general practice rotations.[11] They noted the applicability of comparing documented clerkship experience with educational standards and objectives and thus

identified areas for improvement. They also stated that the teaching performance of the general practice tutors and members of their practice team could be assessed and compared. Finally, weaknesses in any component of general practice education could be identified and improved. Specifically they identified four areas that, if strengthened, could enhance the educational experience of medical students in general practice. First, they felt the students were experiencing too few home visits. Second, students spent limited time on self-education. Third, student participation in procedures was too infrequent and finally, the students should have been encouraged to play a more active role in examining and interviewing patients.

Schamroth and Haines (1992) used logbooks to document 42 students' clerkship experience on randomly selected days of a general surgery clerkship.[12] Again they were able to identify weakness in the rotation studied. Their specific areas of concern were that the students spent insufficient time actively taking histories and examining patients, that they received little feedback and supervision on their examination and history-taking skills and that they performed few practical procedures. In addition the authors noted the failure of the staff to address social and psychological factors in doctor-student discussions on patients, the large amount of time spent in formal lectures, the large amount of time the students felt was unproductive, the relatively few patients available for assessment. They also pointed out that medical students were poorly equipped and/or motivated to make use of unstructured time.

Expanding on Schamroth and Haines' findings that students were undertaking few procedures, Wade et. al. (1993) sought to determine if surgical clinical clerks were exposed to and given the opportunity to practice 18 skills deemed essential by medical staff.[13] They found that the 25 students studied had insufficient exposure to various clinical skills and suggested that the situation could be improved by encouraging simultaneous exposure of all clinical clerks when the techniques were performed. Similarly, Bornstein et. al. demonstrated that of the 184 students studied, only 19.6% of students were exposed to all essential clinical activities (obstetric history and physical

examination, following person in labor with cervical checks, assisting in deliveries, gynecologic history and physical examination to name a few) during their obstetrics and gynecology rotation.[14]

As demonstrated by these studies, documentation of clinical experience was useful for determining how students spent their day during clerkship rotations. The following common weaknesses in clerkship design were identified by the studies: 1) insufficient procedural experience, 2) insufficient numbers of clinical assessments and 3) inadequate exposure to common medical problems. Using this information, the authors were able to make alterations to improve the experience.

The next section reviews research into determining the uniformity of clerkship experience at multiple sites.

Documenting Experience at Multiple Clerkship Sites

Gordon et. al. (1977) identified the following problems inherent to most multi-site clerkships: community-based teaching faculty typically have only tangential ties to the university and little or no formal training in teaching, students dispersed in widely varying sites are likely to have experiences of limited comparability, there is little opportunity to monitor the quality of the students' educational experiences in dispersed settings, and inadequate communication occurs between university-based course coordinators, community-based faculty, and students.[5] Various studies attempted to address some of these issues by documenting and comparing experience offered at various sites.

Gordon et. al. had 35 students at the various hospitals record select details about each patient contact on a special form.[5] By analyzing the recorded experience, the authors showed that experience offered at various sites was comparable. Bornstein et. al. used a "report card" in which students would document exposure to 30 essential clinical skills during their obstetrics and gynecology rotation.[14] They demonstrated that various sites offered experience in all critical

activities 85.3% of the time. The authors further showed that little difference existed between sites in terms of student activities.

Gordon et. al. and Bornstein et. al. demonstrated apparent uniformity in clinical experience between sites. Several studies disagree with this finding. For a randomly chosen one week period, Friedman et. al. used a combination of observation of each student by an investigator, a diary and a questionnaire, to assess clinical experience at various hospitals during an obstetrics and gynecology rotation..[6] The diary and questionnaire were filled out and returned by 36 medical students. They found marked variability in proportions of academic activity and clinical conditions seen between community-based clerkships and teaching hospital clerkships. At the teaching hospital, higher percentages of student time were devoted to rounds, other interaction with faculty and staff on the hospital floor, and laboratory work, and much less time was devoted to clinic activity than was the case at the community hospitals.

Similarly, by using logbooks to document experience during the last week of a surgery clerkship, Calhoun et. al. demonstrated marked variation in clinical activities performed by the 168 students studied at various hospitals.[15] When grouping the activities according to service (patient care) and education (rounds, teaching, reading etc.) they showed that despite this variation, the proportion of time spent at service compared to educational activities remained constant between sites. Students with more seniority, that is, rotating later in the year, were given more time to spend at educational activities.

Sheldon et. al. also used logbooks to record the activities of 211 students.[16] They concentrated primarily on educational activities. They demonstrated differences in the amount of time spent teaching the students at various clerkship sites. The authors noted the possible utility of this data to assist with allocation of educational funding. Ferrel also demonstrated marked variation in the experience encountered by 75 students at various sites.[17] She identified areas of deficiency and made changes to the content and structure of the family medicine clerkship under study.

As demonstrated by the above studies, significant variations in clerkship experience can occur in a multi-site clerkship. Apart from the nature of the clerkship experience, differences might exist on examination scores of students trained at different sites. Several studies have examined if different clerkship sites resulted in different clerkship scores.

Schwartz et. al. first used a pre-rotation MC examination and the National Board of Medical Examiners (NBME) Part I Examination to determine the pre-rotation ability of 217 students.[18] They found no differences between sites for the NBME Part I exam or pre-rotation MC exam. They noted that students with more clinical experience (obtained in previous rotations) tended to perform better on the pre-rotation MC exam. They then looked at two examinations written at the conclusion of the rotation (clinical grade for the clerkship, a 3 hour final examination testing knowledge in general surgery, orthopedics, anesthesiology and urology). Scores for each of the subsections of the final examination were analyzed separately. They found that significant differences in examination scores existed between hospitals. They found that hospitals rated highly for quality of teaching by students and faculty had lower mean scores than those rated poorly. They surmised that "poor" hospitals had lower volume experience and thus allowed more time for independent study resulting in higher scores. Conversely "high quality" hospitals were busier and allowed less time for independent study resulting in less satisfactory scores.

Irby et. al. also explored differences in examination scores across hospitals.[19] The clerkship studied consisted of either a 4-week course at the University of Seattle (N=71), a military hospital in Tacoma (N=31), a 6-week course at a private hospital (N=7), a health maintenance organization in Seattle (N=11), private hospitals in Spokane (N=19), and Boise (N=24). All 163 students began the rotation with a common half-day orientation and 50 item MC pre-test at the University followed by orientations at each site. Course objectives and examinations were similar for all students. The authors demonstrated no significant differences between hospital sites for pre-rotation scores. However, there were differences between sites for some of the post-rotation outcome scores, namely post-rotation MC, ratings of case presentations, case history write-ups and assessment of clinical

performance. The authors noted that the majority of students who scored less satisfactorily on these outcome measures experienced a shorter rotation, rotating at the University of Seattle or the military hospital in Tacoma.

In contrast to these results, other studies have shown that evaluation scores between various hospitals are similar. McCarthy et. al. used various outcome measures (a 55 item MC examination constructed to match departmental information objectives, an essay and 2 multiple choice items exploring attitude objectives) to record the post-rotation knowledge of 669 students rotating at various sites.[20] Course objectives and outcome measures were the same for all students regardless of site. Despite differences in experience acquired (as ascertained by documenting exposure to procedures both before and during the surgical clerkship), no differences existed for outcome scores.

Joorabchi et. al. demonstrated variation in patient and hospital demographics and thus inferred that differences existed in pediatric clerkship experience.[21] They then assessed the pre-rotation ability of 179 students using a MC examination. Post rotation knowledge and ability were determined by patient-management problems and MC scores. They found no difference between hospitals on any of the examinations.

Similarly, Baciewicz et. al. looked at the pre-rotation ability of 139 students as estimated by examination scores during undergraduate medical training.[1] They then analyzed written and oral examination scores for each site, time of year the rotation was done and rotation structure (varying mix of cardiothoracic surgery, general surgery and other subspecialties). They found no differences between hospitals for any of the tests used.

Strand et. al. had 875 students record the number of student exposures to eight obstetrics and gynecology procedures at various clerkship sites.[22] They were able to identify sites deficient in various procedures and notified them of the deficiencies. They also conducted teaching workshops to improve teaching ability at the sites. Despite documented variation in experience, the authors noted no differences on examination scores (a written test, an oral examination and faculty

assessments of written patient workups, oral presentation and clinical performance) between the sites.

Similarly, Bornstein et. al. noted no differences on "cognitive examinations" between sites offering varied experience.[14] Ende et. al. demonstrated no differences between hospitals with respect to 151 students' background knowledge (scores on the NBME Part I and MC final examination taken prior to the onset of the first clerkship year) and end of rotation examination scores (NBME Part II)[8]. Collins et. al. noted no significant differences in mean objective structured clinical examination (OSCE) scores for 103 students at various clerkship sites.[23] Whalen et. al.[24] and Jacobson et. al.[25] demonstrated similar clerkship grades (subjective rotation grade, NBME-I and clerkship final examination) between rotation sites.

The above studies demonstrated that there can be significant variations in experience offered clinical clerks at various clerkship sites. Those studies analyzing student pre-rotation ability demonstrated uniform distribution of student ability at various sites. Taking these considerations into account, some papers showed similarities in objective measure scores whereas others demonstrated dissimilar performance between sites. As a result of these conflicting studies, the impact of variable experience in influencing medical student performance remains unclear.

The papers reviewed in the preceding section dealt with the impact of clerkship training at disparate hospital sites. The next section deals with the impact of clerkship training at various non-traditional sites such as outpatient clinic, physician offices or rural practices.

Monitoring Experience at Non-Traditional Teaching Sites

Over the years, increasing emphasis has been placed on providing students with more ambulatory and outpatient exposure. This allows them greater exposure to common medical

problems and places less emphasis on medical minutiae. Both the nature of these modified clerkships and their educational impact has been studied.

The majority of studies done in this area have analyzed the experience offered students at rural rotation sites or outpatient clinics. The first documented study was done by Garrard and Verby[7]. They used logbooks, filled out by the student, to document various demographic parameters of the student-patient encounter. Such parameters as the location and month of the encounter, patient demographics, onset of patient's problem, continuity of patient care (initial contact versus continuing care), and diagnosis were documented. Data were collected by 36 students undertaking a rural Minnesota family or internal medicine rotation and by 26 students taking the traditional city hospital based clerkship. They found that students exposed to a rural rotation reported proportionately more encounters with patients who presented with a primary clinical problem that was new to the patient. It was assumed from these results that the students exposed to these patients would have a greater opportunity to practice their diagnostic and problem solving skills than the hospital based clerks who saw more patients with a known diagnosis. The authors demonstrated that the students rotating through rural settings saw proportionately more pediatric and well-baby encounters.

Similarly, Parkerson showed that patient logbooks were useful to document clinical experience on a new family medicine clerkship consisting of model family physician offices.[26] Forty students partaking in the family medicine clerkship were exposed to higher numbers of patients with circulatory, respiratory, digestive, neurological, musculoskeletal, and skin problems than those involved in traditional clerkships. The authors concluded that the family medicine clerkship contributed significantly to the traditional clinical clerkship curriculum.

Greer et. al. used logbooks to document the experiences of 68 students during the final two weeks of a family medicine clerkship.[27] They compared the experience offered at eight regional community centres throughout Washington, Alaska, Montana, and Idaho (N=40) against experience at nine affiliated family practice residency programs (N=28). Despite differences in experience

between these community based clerkships and the community centres, the authors found that all students met the course curriculum goals.

While these studies reported the feasibility of using rural and community clinics to facilitate family medicine clerkships, few studies attempted to address the impact of this outpatient experience on examination scores. Papadakis and Kagawa used three performance measures to compare the scores of 10 students exposed to an ambulatory care clinic for a half a day a week with 30 students who had no exposure to this clinic.[28] They used a final clerkship evaluation, standardized-patient exercises (ambulatory care problems), and student self-assessment of their skill and knowledge to compare performance. They found no significant difference between the two groups for the assessments used. The authors state that they failed to show that this ambulatory clinic experience improved the students' cognitive and non-cognitive skills. They assumed that this was due to too limited an experience, small sample size, or failure of the assessments to detect the differences.

In contrast to this, Greene used an oral examination, the NBME "shelf" test in surgery and an MC examination taken at the conclusion of a rotation to compare performance of 221 students exposed to a breast clinic with 332 students not exposed to the breast clinic. Only those questions pertaining to breast diseases were used. He demonstrated improvement in the knowledge of breast pathology and examination techniques of the students exposed to a breast clinic compared to those not exposed this clinic.[29]

Ambulatory and outpatient clinic experience has become an essential component of medical training. Intuitively this type of exposure should be beneficial for the students, allowing students experience in dealing with common office medical problems. However, as demonstrated by the above studies, further work needs to be done to determine the benefit of this experience.

The remaining section deals with those papers that have studied the impact of clerkship experience on examination scores.

Studies Assessing Medical Student Knowledge Gain During Clerkships

While it has not been possible to demonstrate a consistent change in examination performance as a result of a different clerkship experience, several authors have attempted to determine if the duration of the experience, experience obtained during previous rotations, or experience gained during the rotation being studied, influenced medical student knowledge gain. Several researchers have reported an improvement in examination scores for those students partaking in a longer rotation. Joorabchi et. al. demonstrated that students who obtained more experience through third year electives did better on their multiple choice comprehensive examination.[21] Similarly Irby et. al. surmised that a shorter rotation was responsible for less satisfactory student performance.[19] Jacobson et. al demonstrated that students taking a longer clerkship scored significantly higher on NBME, oral examination and evaluation of clinical performance than did students in a shorter clerkship. These studies suggest that longer clerkship experience was beneficial to medical student knowledge gain. However, Gary and Rosevear showed no change in NBME Part II scores between students completing a longer versus a shorter clinical clerkship.[2] Baciewicz et. al. reported similar results.[1] They found that added experience during electives did not improve examination scores.

When analyzing the impact of rotation timing on examination scores, some researchers were able to demonstrate improvement in examination performance for those students rotating toward the end of the year. This suggested that experience obtained during previous rotation impacted favorably on examination marks. Collins et. al. found that students completing their rotation at the end of the year tended to perform better on their surgery OSCE.[23] Whalen et. al., demonstrated improvement in mean clerkship grades in those student rotating toward the end of their training.[24]

In contrast to this, several researchers found that previous experience had no impact on examination scores. Baciewicz et. al.. found that student oral examination scores were similar for all rotations irrespective of time of year.[1] However students tended to perform better on written exams later in the year. Schwartz et. al. found no differences between rotation blocks for various performance assessment.[30] Similarly, Miller et. al. found no differences in mean scores on a pre- or post-rotation surgical examination between rotation blocks.[31] Magarian et. al. found no difference in pre-rotation NBME scores between rotation blocks[32], and Stillman demonstrated that scores for the pre and post-rotation examinations did not improve through the year.[3] The results of these studies suggest that there is no demonstrable benefit from previous non-surgical rotations.

The preceding studies attempted to determine if increased experience meant improved performance. However, they were only able to make inferences about the nature of the experience and thus were restricted to assuming student knowledge gain resulted from the experience. The benefit of clerkships and modifications to existing clerkships has been studied further.

Several studies have shown improvement in student scores from a pre- to a post-rotation test, suggesting that rotation experience or modifications to the rotation increase student knowledge gain. Stillman found significant improvement in the students scores from a pre-rotation multiple choice examination to several post-rotation examinations.[3] Similarly, Magarian et. al. demonstrated improvement between the pre- rotation and post- rotation NBME examination.[32]

The benefits of modifications to the clerkship were demonstrated by Ende et. al.[8], Greene[29] and Dunnington et. al..[33] Ende et. al. sought to improve clerkship experience by introduction of a structured curriculum. Comparisons of scores between two hospitals without the structured curriculum and one with the structured curriculum revealed no differences. However, when controlling for pre-existing knowledge using regression analysis they showed improvement in those with the structured curriculum. As previously mentioned, Greene showed that medical students exposed to a breast clinic demonstrated better knowledge of breast pathology and examination techniques than those not exposed to the clinic.

Dunnington and Hoffman further demonstrated the benefit of modifying the clerkship after they described a "clinical skills deficiency syndrome" whereby students displayed a disturbing lack of proficiency in basic clinical assessment techniques at the end of their rotations. They felt this resulted from lack of feedback and evaluation of the students' clinical skills. The authors introduced a competency based clinical clerkship consisting of orientation to expectation, immediate and frequent feedback on student assessments and the requirement that students display proficiency at several essential clinical skills prior to completion of the rotation. One hundred thirty six students who rotated through this clerkship showed marked improvement in physical examination techniques through the academic year.[34]

Schwartz et. al. also sought to improve the clerkship design. Using a pre-test and post test multiple choice examination (the NBME "shelf examination") as well as two multiple-choice examinations, a modified-essay examination, a standard-patient examination and an OSCE, the authors demonstrated significant knowledge gain during a problem-based clerkship.[30] However, no comparison was made with traditional clerkship designs so the benefit of PBL over traditional clerkships was not demonstrated by this study.

While these studies answer some questions about the benefit of select portions of the clerkship experience, the overall benefit remains to be consistently proven. In addition, more research needs to be done to demonstrate the relative merits of service versus educational experience as well as the benefit of various clerkship duties.

Summary

Documenting student clinical experience has shown to be an effective method of monitoring the nature of the overall clerkship, multi-site clerkships and ambulatory or non-traditional clerkship sites. Several authors have stated the benefit of collecting this information to identify and rectify deficiencies in clerkship experience.

Studies have demonstrated the benefit of select aspects of clerkship experience. Others have shown that despite large variation in experience, students perform similarly on rotation examinations. In addition, some studies demonstrate the benefit of lengthier clerkship experience whereas others do not.

Conflicting results were reported for determining the effect of prior rotation experience on clerkship performance. Some studies clearly demonstrate that students rotating later in the year, with more clinical experience from previous rotations, perform better than those with less experience. Conversely, some studies show no effect of previous clerkship experience on rotation scores. As a result of these conflicting studies, further study is required to determine the role of clerkship experience in benefiting student knowledge gain.

The following sections discuss the research that has been done to attempt to address the above issues for the surgery clerkship at the University of Alberta.

Chapter 3

Methods

In this chapter, the following will be discussed. The surgical clerkship for the class of 1995 will be presented including a description of the students involved in the study, the hospitals they rotated in and the nature of the rotation. The logbooks used to record clerkship experience information will be described as will the examinations used to assess surgical knowledge and ability. Finally, the method of data analysis will be presented

The Surgical Clerkship

Subjects:

One hundred and thirteen students from the class of 1995 were assigned to one of four ten-week surgical rotations. Students were able to request the time and location of one or two of their clerkship rotations. Thus the assignment process was not entirely random. Those who did not choose to set the time and date of their surgery rotation were assigned by the faculty to their respective rotations. The rotations ended in February, May, August and November 1994. Because the academic year ends in May, some of the students were completing their third and others were in their fourth year. Students for each rotation were assigned to one of four affiliated teaching hospitals. Each was assigned to a preceptor during the rotation.

Hospitals:

Two of the hospitals were tertiary and trauma care centres. The remaining two were community-based hospitals. All hospitals had fully functional intensive-care units, allowing full exposure to major general surgery cases. The students' exposure to these major cases relied heavily on the nature of their preceptor's practice. All major trauma surgery was referred to the two trauma care centres.

Rotation:

At the beginning of the rotation, students undertook a common first day rotation orientation to familiarize themselves with rotation objectives. Each was given a logbook in which daily clerkship experiences were to be recorded. They were then oriented to proper logbook data entry. All were required to return a completed logbook in order to receive their final mark for the rotation.

All students received the same course manual and list of objectives. During the rotation, the students received similar core topic teaching sessions during weekly academic seminars. These seminars occurred during protected academic times; students were freed from clerkship duties to facilitate attendance.

All students were expected to perform elective admissions of their preceptors' patients and assist their preceptor in the operating room whenever feasible. In addition, they were expected to attend as many of their preceptors' ward rounds, offices and outpatient clinics as possible.

The majority of exposure to emergency surgery was obtained while the students were on call. For this reason, they were expected to take in-house call one out of every five to seven days. The students' on-call duties consisted of supervised post-operative care, specifically dealing with common post-operative complications such as low urine output and febrile conditions. They were also expected to "shadow" the resident in the emergency department and scrub on emergency surgeries whenever possible.

Logbooks

Each logbook was a 40-page, bound, paper backed manual carried in the clerk's pockets at all times. These were developed at the University of Alberta by Dr. Warnock in 1986 and preliminary data on their use was recorded in an earlier pilot study.[41] Space was provided for hand-written data entry in the following formats (Figure 3-1 through Figure 3-5).

Students recorded elective history experience in the format outlined in Figure 3-1.

Duties During Phase III General Surgery Rotation
Elective (include PAC)
Histories and Physical Examinations

Patient No.	Admission Diagnosis	Date	History Correction? Yes	No

Figure 3-1- Format for Recording Elective History Experience.

Using this form, the students recorded the patient's identification number, diagnosis, date of contact and whether or not the history was corrected. This form was used to record each occasion the student performed a history and physical examination on patients admitted to hospital for elective surgery either through the pre-admission clinic (PAC) or through direct admission to the ward.

The PAC consisted of daily admission clinics whereby patients would receive preoperative assessment and investigation several days prior to their admission for surgery. This facilitated timely

and efficient preoperative patient workup. The patients could subsequently be admitted to hospital the night before or the same day as their surgery. The students were responsible for all PAC assessments and admitted their preceptors' patients whenever possible. The majority of elective surgery patients were admitted this way. Those patients with complicated medical or surgical problems or who required preoperative hospital care to optimize their medical condition prior to surgery were admitted directly to the ward without attendance at PAC. Clinical clerks were responsible for admitting these patients.

While the logbook did not reflect the method of feedback, this would have occurred in one of three ways: 1) the history was read and signed by the resident (or staff), 2) the history was read, corrective notes were made in the margins and the history was signed, or 3) the student would sit down with the staff or resident and discuss the admission in a one-on-one fashion.

Several deficiencies were noted in this method of feedback for PAC admissions. PAC admissions were done during the day when the residents and staff were in the operating room (OR). This made daily resident participation in the clinics difficult. Thus the majority of the histories were signed after the OR's were complete, generally after the students had left the clinic. Thus immediate feedback in any form, especially one-on-one feedback likely occurred infrequently.

Since the patients were not readmitted to hospital for several days, it was incumbent upon the student to remember who they assessed, go back to the history and re-read their admission notes and the corrections made by the resident. Thus, when the students re-read their histories, they likely did not receive feedback on their assessments for days or weeks after the history was performed. If they did not take the initiative to follow-up on their assessments, they received no feedback.

In addition to elective admissions, the students were occasionally exposed to patients with emergent surgical problems and were encouraged to partake in supervised assessments of these patients.

Emergency assessments were recorded in the format shown in Figure 3-2.

Emergency Admissions Including Acute Abdomen

Patient No.	Admission Diagnosis	Date	You did admission history	Resident did admission history

Figure 3-2 - Format for Recording Emergency Admission Experience.

Using this form, the students recorded the patient's identification number, admission diagnosis, date of contact, whether they did the history and whether the history was corrected by the resident.

Again the logbooks did not reflect the method of feedback. However this could have occurred as follows. The student would accompany the resident or staff to the emergency department. They were often asked to assess the patient. After completing the assessment, the student and resident or staff would sit down and discuss the case in a one-on-one fashion. Thus the student would receive immediate feedback on the strengths and weakness of their assessment and would often receive informal teaching about the case.

In addition to the above duties, students were required to scrub in the OR with their preceptor as much as possible. Each time student's scrubbed they recorded their experience as follows (Figure 3-3).

Duties During Phase III General Surgery Rotation

Operative Experience

Patient No.	Operation Done	Date	Service	Did you write post-op Note	Orders

Figure 3-3 - Format for Recording Operating Room Experience

Using this form, the students recorded the patient's identification number, operation performed, date of operation and whether they wrote post-operative orders or notes.

Ward procedural experience was recorded as follows (Figure 3-4).

Log of Duties During Phase III Rotation

Procedures You Have Personally Done or Observed

Procedure	Done? (check one)	Observed? (check one)
- intravenous insertion		
-NG tube insertion		
-chest tube insertion		
-central venous cannulation		
- sigmoidoscopy		
- cast application and removal		
- suture insertion and removal		
- removal surgical drains		
- removal sump drains		
- resuscitation of multiple trauma patient		
- endotracheal intubation		
- insert foley catheter, male female		
- femoral artery puncture		
- radial artery puncture		
- resuscitation of arrested patient (pediatric/adult)		
- advise patient of malignant diagnosis		
- manage post-op fever in surgical patient		
- manage low urine output in surgical patient		
- other procedures continued		

Figure 3-4 - Format for Recording Ward Procedures

Using this form, the students were able to record ward procedures they either performed or observed. They were provided with a list of common procedures as well as space for recording procedures not presented in the list.

Outpatient clinic experience was recorded as follows (Figure 3-5).

Clinic	Preceptor	No. of patients seen

Figure 3-5 - Format for Recording Outpatient Experience

Students recorded the date of the clinic, the preceptor they attended the clinic with and the number of patients seen.

From the logbooks the number of each of the following experience variables was determined for each student.

1. clinical history and physical examination write-ups for elective surgery.
2. clinical history and physical examination write-ups performed in the emergency department.
3. whether feedback was received on the above clinical write-ups.
4. operating room scrubs (OR Scrubs)
5. ward procedures performed.
6. outpatient clinic experiences (OPD)

The quantity of each experience variables was tabulated for every student at individual hospitals for the entire ten week rotation.

The following section describes the examinations used to assess student knowledge of surgical principles.

Assessments

Three groups of performance assessments were used. The first consisted of a MC examination, an OSCE and a rotation score. These assessments were conducted at the conclusion of the rotation (outcome variables). Using these post-rotation scores, the Department of Surgery achieves a comprehensive post-rotation measure of surgical knowledge, clinical competence and interpersonal relationship skills. The second group of performance assessments consisted of two multiple choice examinations written at the conclusion of the students' undergraduate training and prior to the onset of the surgery rotation (background variables). Scores on these examinations estimated student pre-rotation surgical knowledge. The final performance assessment was a MC examination taken at the conclusion of medical school training (knowledge retention variable). Scores on this examination estimated the students' retention of knowledge of surgical principles.

Outcome Variables

Scores on the following outcome variables were used as an estimate of post-rotation surgical knowledge and ability.

1. Multiple Choice Examination

The first outcome variable was a 50 item multiple-choice examination (MC) taken at the conclusion of the rotation. Two examinations were used, each rotation block writing one of the two examinations. The examinations tested the same principles but used different questions.

The distribution of items according to emergency, elective and outpatient knowledge follows in Table 3-1.

Table 3-1- Distribution of items on the MC examinations.

	Examination 1	**Examination 2**
Emergency Surgery Questions	34%	32%
Elective Surgery Questions	60%	60%
Outpatient Surgery Questions	6%	8%

The mean scores ($\overline{X}$) for the first examination was 67.02 with a standard deviation (S. D.) of 8.02. The $\overline{X}$ for the second examination was 75.21 with a S. D. of 6.52. Because the $\overline{X}$'s for the two examinations significantly differed ($p<0.0001$), the student grades for each examination were standardized to a mean of 70 with a standard deviation of 5.

For each rotation block, the means and standard deviations (SD) were calculated. Z scores were computed for each student using the following formula.

$$Z = \frac{X - \overline{X}}{SD}$$

Computed standard scores (standard score = 5(Z) + 70) were used for this study.

2. Objective Structured Clinical Examination (OSCE)

The second performance measure was the OSCE. This consisted of eight ten-minute stations constructed to be a test of the students' knowledge of surgical principles and their ability to properly assess patients with elective and emergent surgical problems.[35,36] The OSCE was taken at the conclusion of the rotation.

The contents of the OSCE follow (Table 3-2). Two of the stations were excluded from the study for the reasons listed.

Table 3-2 - Table of OSCE stations.

Station	Description	Knowledge Tested	Included	Reason for Exclusion
1. Acute abdomen*	patient assessment	knowledge of emergency surgery	no	not all examinations contained this station
2. X-ray interpretation	students view surgical X - rays and receive grade for their interpretation of same.	knowledge of emergency surgery	yes	
3. Breast mass*	patient assessment	knowledge of elective surgery.	yes	
4. Penetrating extremity trauma*	patient assessment	knowledge of emergency surgery.	yes	
5. Thyroid mass*	patient assessment	knowledge of elective surgery.	yes	
6. Rectal bleeding*	patient assessment	knowledge of elective surgery.	yes	
7. Surgical pathology	students answered knowledge probe questions after viewing surgical pathology specimens.	knowledge of surgical disease states	no	two OSCE's used different knowledge probe questions
8. Jaundice*	patient assessment	knowledge of emergency surgery	yes	

Stations marked with an asterisk required students to perform a brief but comprehensive history and physical examination on trained simulated patients with the surgical problem listed. While the students conducted the assessments, staff surgeons observed and scored the students' proficiency using a standardized checklist of critical components of the history and physical examination for each problem. The students were then asked standard questions intended to test their knowledge of the surgical problem being examined. They received a grade for the proficiency and completeness of their assessment and knowledge of the problem encountered.

Stations 2 and 7 required the student to view and interpret surgical X-rays and pathology specimens respectively. They were then required to fill out a short answer sheet with answers to pertinent questions relating to the X-rays and specimens viewed. Scores were given for the accuracy of the interpretation as well as knowledge of the examples presented.

For the purposes of analysis, the students' overall OSCE score, determined by calculating the overall mean of the OSCE stations, was used. The scores from the OSCE stations were further analyzed as follows. Mean scores for stations testing elective surgical knowledge were calculated. Similarly, mean scores for stations testing emergency surgical knowledge were calculated. Grades for each of the patient assessment stations were then divided into history, physical examination and knowledge probe components. Mean scores for these components were calculated both for the elective surgical stations as well as the emergency surgical stations.

3. Rotation Score

The final outcome measure was the preceptors' overall subjective assessment grade of the students' performance during the rotation. This score was often determined with input from all members of the health care team including nurses and residents. For a representation of the form used for this assessment see Appendix A. This score is intended to measure the surgical staffs' perception of the students' clinical knowledge, competence, interpersonal relationship skills, and their ability to practically apply these attributes to surgical patients. While this method of assessment has been shown to correlate poorly with other methods of assessment, when considered as a portion of the overall evaluation process, rotation evaluations can contribute useful information about student clinical competence.[8,37,38]

Background Variables

The students took two multiple choice examinations before the onset of the rotation: 1) The supplemental surgery examination (SS) examination, a multiple choice examination written after

the students' second year surgery lecture course, and 2) the second year comprehensive examination (SC), a multiple choice examination on all medical disciplines including surgery, written at the conclusion of the second year lectures. Only those questions pertaining to surgery were included in the study. Scores on these examinations were used as an estimate of student pre-rotation surgical knowledge.

Knowledge Retention Variable

At the conclusion of the students' medical school training, a comprehensive examination (comp.) was administered. Questions on the test examined knowledge of all medical disciplines. Only those questions relating to surgery were analyzed for this study. As this examination was taken at a time remote from clinical rotations, scores were used as an estimate of student knowledge retention.

Analysis

Clinical experience, as recorded in the logbooks, and scores on the background, outcome and knowledge retention variables were compared between clerkship sites using ANOVA. Scheffé's method was used for post-hoc analysis.

In order to assess the impact of clinical clerkship experiences on examination performance the following three methods were used. First, student scores on performance variables were compared between rotation blocks using ANOVA with Scheffé's test. This determined if students rotating later in the year, that is with more experience gained in previous rotations, performed differently on examinations than less senior students. In this manner, the impact of experience gained during previous rotations on examination performance was determined.

Second, students were ranked from highest to lowest volume for each experience variable. Performance variable scores for the students with the top 1/3 volume were then compared to

performance variable scores for students with the bottom 1/3 volume of each experience variable using the *t*-test. This allowed the determination of similarities or differences in: 1) the pre-rotation knowledge of students with high volume experience versus students with low volume experience and 2) the post-rotation knowledge of students with high volume experience versus students with low volume experience. An alpha level of 0.05 was used throughout the preceding analyses.

Third, regression analysis was used to obtain multiple correlations between background and outcome/knowledge retention variable scores. The influence of the experience variables on the gain in correlation was determined. Using this technique the impact of clinical experience on the correlation between the students' background surgical knowledge and their end of rotation surgical knowledge/knowledge retention was determined.

Chapter 4

Results

One hundred and nine students returned completed logbooks for a compliance rate of 96%. The remaining 4% were either lost, destroyed or not returned. Grades for the background and outcome variables were available for all students. However, two students dropped out of medical school close to the completion of training and the OSCE station analysis and comprehensive examination scores were not available for these students. Thus the majority of the analysis was conducted on data from 109 students but the OSCE station analysis and comprehensive examination analysis was conducted on 107 students.

The results of the data analysis follow. First, comparison of experience followed by examination performance at the four teaching hospitals will be presented. Second comparison of experience followed by examination performance for each rotation block will be analyzed. Third, examination performance by those students with high volume clinical experience will be compared to performance by those students with low volume experience. Finally, the results of the regression analysis will be presented.

Clinical Experience in 4 Affiliated Teaching Hospitals

The following data presents an analysis of the clinical experiences encountered by students at the various hospitals. The results presented address the first purpose of the thesis: to determine if

student clerkship experiences were similar between sites. Table 4-1 presents the mean and standard deviation for the various experiences at the four teaching hospitals.

Table 4-1 - Volume of Clinical Experiences in Various Teaching Hospitals ($\bar{X} \pm$ SD).

	Hospital			
	A (N=30)	**B (N=19)**	**C (N=23)**	**D (N=37)**
Elective Admissions	54.17 ± 15.66	17.42 ± 9.56	93.17 ± 33.11	40.57 ± 12.10
Elective Corrections	2.90 ± 6.10	2.89 ± 5.08	5.00 ± 4.89	10.95 ± 13.25
Emergency Admissions	12.70 ± 8.11	14.47 ± 5.25	1.73 ± 3.54	8.86 ± 6.61
Emergency Corrections	2.67 ± 4.10	1.89 ± 3.03	0.57 ± 1.95	3.08 ± 3.01
OR Scrubs	66.07 ± 27.43	83.42 ± 42.95	115.87 ± 33.49	69.14 ± 30.68
OPD Clinics	3.40 ± 4.76	12.16 ± 11.15	7.69 ± 6.13	19.57 ± 4.95
Procedures	7.03 ± 5.29	10.79 ± 4.91	10.96 ± 6.57	13.43 ± 5.99

Significant differences were obtained between all hospitals for elective admissions. Students at hospital C performed fewer emergency histories than the other hospitals and students at hospital B performed more emergency histories than hospital D. Students at hospital C performed more operating room scrubs than the other hospitals. Students at hospital A had fewer OPD clinic experiences than the other hospitals and performed fewer ward procedures than hospitals C or D. A proportionately small number of histories were corrected and fedback to the students. However, students at hospital D received more elective history feedback than hospitals A or B and more emergency history feedback than hospital C.

Service Experience: Comparisons of Volume of Elective Admissions, Emergency Admissions, OR scrubs, Procedures.

Figures Figure 4-1 through Figure 4-7 are box and whisker plots of experiences at the four hospitals. These figures demonstrate that for the majority of experiences, marked variation was seen both between and within hospitals. Each figure is described separately as follows.

Figure 4-1 is a box and whisker plot of elective admissions by hospital.

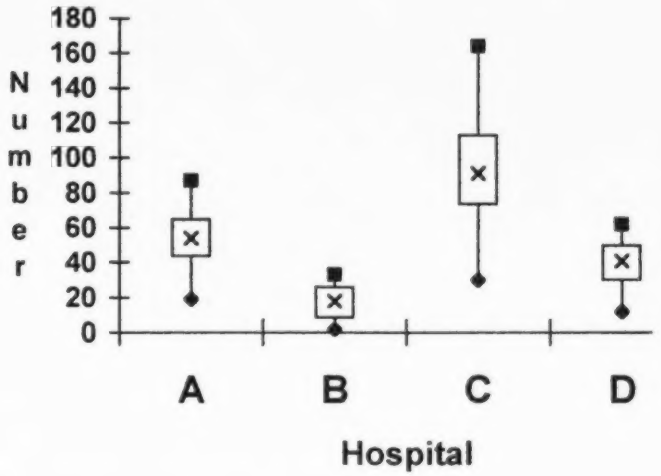

Figure 4-1 - Box Plot of Elective Admissions by Hospital

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-1 demonstrates marked variation in numbers of elective admissions both within and between hospitals. ANOVA revealed significant differences between all hospitals. The maximum number of elective admissions completed by at least one student ranged from 164 at hospital C to 33 at hospital B. The minimum number of elective histories completed by at least one student ranged from 30 at hospital C to 2 at hospital B. The student at hospital B who performed the most elective histories did the same number as the student at hospital C who performed the least, further illustrating the differences between hospitals.

Figure 4-2 is a box and whisker plot of emergency admissions by hospital.

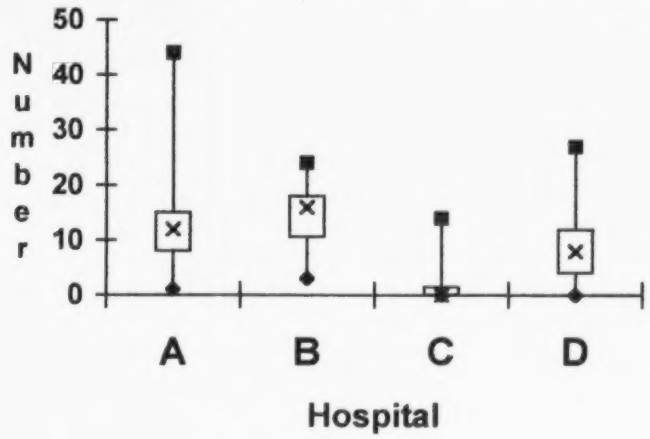

Figure 4-2 - Box Plot of Emergency Admissions by Hospital.

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-2 demonstrates variations in emergency history experience both between and within hospitals. Significant differences between all hospitals were noted for all but hospitals A and B as well as hospitals A and D. The students who performed the most emergency admissions ranged from 44 at hospital A to 14 at hospital C. The students who performed the least emergency admissions ranged from 1 at hospital B to 0 at the other hospitals. Seventy-five percent of students at hospital C performed 2 or less emergency admissions during their rotation.

Figure 4-3 is a box and whisker plot of OR scrubs by hospital.

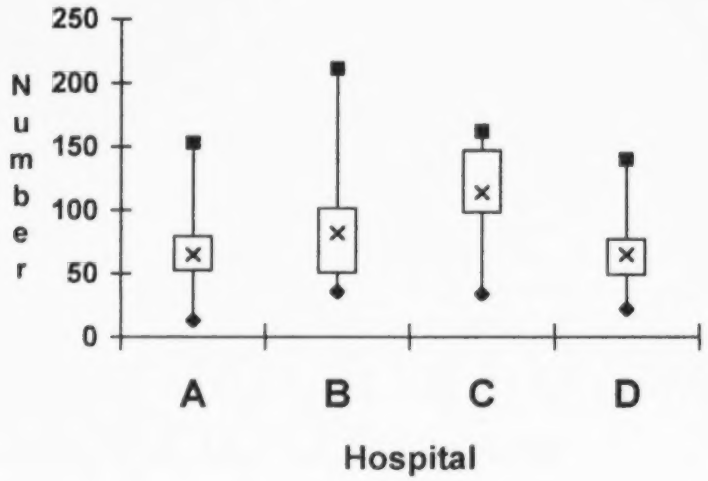

Figure 4-3 - Box Plot of OR Scrubs by Hospital

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-3 again demonstrates the variability of OR scrub experience at the hospitals. Students at hospital C performed significantly more OR scrubs than the other hospitals. No differences were noted between hospitals A and B, A and D and B and D. Students who attended the most OR scrubs ranged from 211 at hospital B to 140 at hospital A. Students who attended the least OR scrubs attended from 36 at hospital B to 13 at hospital A.

Figure 4-4 is a box and whisker plot of ward procedures by hospital.

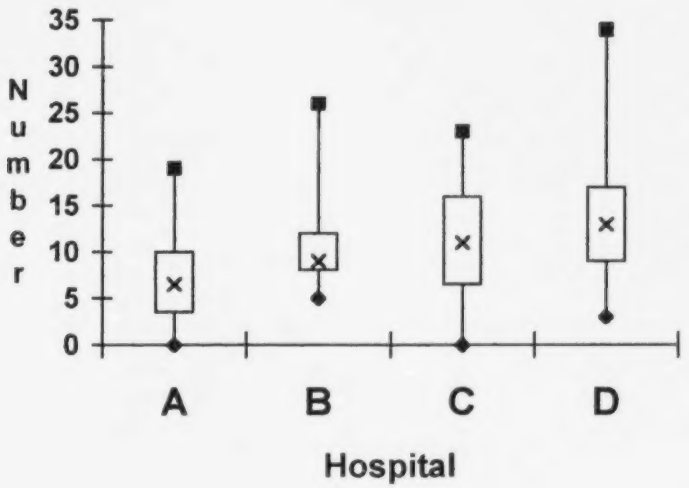

Figure 4-4 - Box Plot of Procedures.

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-4 demonstrates that students at hospital A performed significantly fewer ward procedures than either hospitals C or D. No differences between other hospitals were found. Students experiencing the most ward procedures ranged from 34 at hospital D to 14 at hospital A. Students with the least experience ranged from 5 at hospital B to 0 at hospital A.

Educational Experience: History Feedback and OPD Clinics.

Figure 4-5 is a box and whisker plot of elective history corrections.

Figure 4-5 - Box Plot of Elective History Corrections

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

As seen in Figure 4-5, proportionately few histories were fed back to the students. Twenty-one students received no emergency or elective history feedback. Students who received the highest number of elective admission feedbacks ranged from 47 at hospital D to 20 at hospitals B and C. ANOVA revealed that students at hospital D received significantly more elective history feedback than hospitals A or B. Thirty-seven of 109 students across hospitals received no elective history feedback during their rotation.

Figure 4-6 is a box and whisker plot of the number of emergency corrections by hospitals.

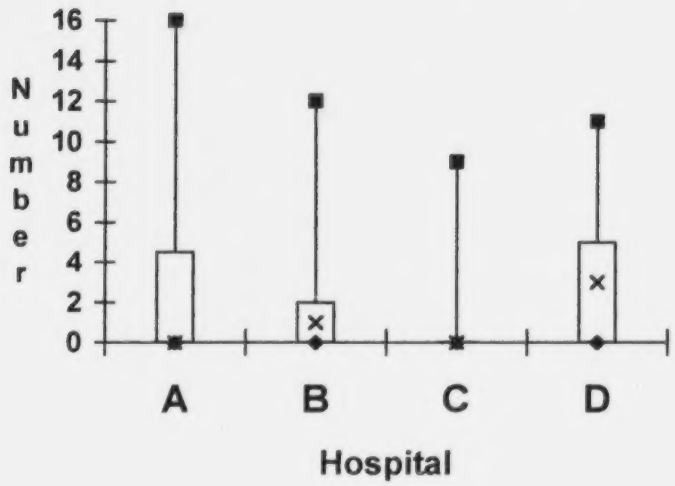

Figure 4-6 - Box Plot of Emergency Corrections

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-6 demonstrates that the students with the highest number of emergency admission feedbacks received from 16 at hospital A to 9 at hospital C. ANOVA showed that students at hospital D received more emergency history feedback than hospital C. Fifty-seven of 109 students across hospitals received no emergency history feedback during their rotation.

Figure 4-7 is a box and whisker plot of numbers of OPD experiences by hospital.

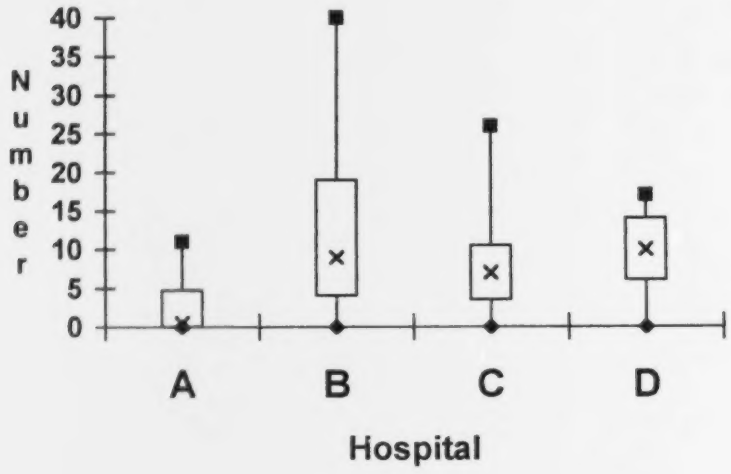

Figure 4-7 - Box Plot of OPD Experience.

x = median

■ = student with the highest volume experience

◆ = student with the lowest volume experience

boxed = first to third quartile

Figure 4-7 demonstrates that students with the most OPD exposures ranged from 40 at hospital B to 11 at hospital A. Several students at all hospitals had no OPD exposure during their rotation. Students at hospital A were exposed to significantly fewer OPD clinics than the other hospitals. No other differences were found.

The above figures demonstrate that student experience during their clinical clerkship varied greatly according to the hospital in which they were assigned for their rotation. Further, student experience varied greatly within hospitals as some students at the same hospital experienced a larger volume of activities than others.

Examination Performance in 4 Affiliated Teaching Hospitals

The following section deals with the second purpose of the study: to determine if the students' examination performance was similar between sites.

Background Variables

Table 4-2 presents means and standard deviations for each of the background variables by hospital.

Table 4-2 - Background Variable Scores (%) by Hospital ($\bar{X} \pm$ SD).

Examination	Hospital A (N=30)	B (N=19)	C (N=23)	D (N=37)
Supp. Surg.	78.93 ± 5.71	77.42 ± 6.30	78.30 ± 4.95	79.7 ± 55.10
Surg. Comp	73.53 ± 7.69	71.92 ± 10.28	73.00 ± 13.93	76.81 ± 9.50

ANOVA showed no significant differences between hospitals. This suggests that students at each of the hospitals had a similar knowledge of surgery prior to the rotation.

Outcome Variables.

Table 4-3 presents means and standard deviations for each of the outcome variables by hospital. The calculated reliability coefficient for the MC was 0.67. The KR-20 reported reflects an

estimate of the combined KR-20 for all of the examinations.[39] The coefficient α for the OSCE was 0.48.[40]

Table 4-3 - Outcome Variable Scores (%) by Hospital ($\bar{X} \pm$ SD).

Outcome Variable	Hospital			
	A (N=30)	B (N=19)	C (N=23)	D (N=37)
OSCE	79.47 ± 6.84	79.60 ±5.46	77.67 ± 5.34	77.37 ± 6.81
MC	69.95 ± 4.37	70.69 ± 6.16	69.85 ± 5.24	69.85 ± 4.91
rotation mark	80.56 ± 3.73	78.32 ± 5.68	78.83 ± 6.16	78.31 ± 6.39

ANOVA showed no significant differences between hospitals. This suggests that student post-rotation knowledge was similar between hospitals.

Scores on the OSCE stations were further divided by station components. These components were grouped by knowledge tested and subsequently analyzed.

Table 4-4 presents the mean and standard deviation of each of the OSCE component scores by hospital.

Table 4-4 - OSCE Breakdown (%) by Hospital ($\bar{X} \pm$ SD).

	Hospital			
	A (N=30)	B (N=19)	C (N=23)	D (N=37)
Mean Elective Station Mark	79.62 ± 5.04	79.87 ± 4.28	77.77 ± 5.00	77.46 ± 5.17
Elective History Taking	79.50 ± 7.73	80.14 ± 7.88	80.47 ± 8.69	78.50 ± 9.60
Elective Physical Examination	82.69 ± 5.84	83.91 ± 5.84	80.41 ± 8.84	81.15 ± 7.64
Elective Knowledge	76.19 ± 7.45	76.33 ± 6.64	71.10 ± 5.58	74.48 ± 5.58
Mean Emergency Station Mark	72.22 ± 7.49	71.02 ± 6.95	68.96 ± 6.85	69.65 ± 7.23
Emergency History Taking	61.36 ± 14.82	62.08 ± 12.85	60.87 ± 13.03	60.26 ± 11.28
Emergency Physical Examination	81.10 ± 9.86	79.83 ± 10.02	80.95 ± 9.61	77.59 ± 11.30
Emergency Knowledge	84.02 ± 11.95	84.61 ± 5.54	79.57 ± 14.14	83.45 ± 8.07

ANOVA revealed no differences in OSCE component scores between hospitals. Thus, despite marked differences in experience seen at each of the hospitals, student scores on each of the OSCE components were similar.

Knowledge Gain Variable

Table 4-5 presents the mean and standard deviations for the comprehensive examination at each of the hospitals.

Table 4-5 - Comprehensive Examination Mark (%) by Hospital ($\bar{X} \pm$ SD).

	Hospital			
	A (N=30)	**B** (N=19)	**C** (N=23)	**D** (N=37)
Comp.	71.38 ± 8.40	70.82 ± 7.31	70.37 ± 8.78	69.72 ± 8.45

ANOVA revealed no differences in scores between hospitals. This again suggests that despite marked variation in experience, student retention of surgical knowledge was similar.

Clinical Experience by Rotation Block

This and the following section deals with the third purpose of the thesis, to determine if the experience gained during previous rotations impacted examination performance. First, data on clerkship experiences encountered during each rotation block will be presented thus determining similarity or differences in rotation experience during each rotation. Second, data on examination performance during each rotation block will be presented thus determining similarities or differences in student pre- and post-rotation knowledge between rotations.

Table 4-6 presents means and standard deviations of the number of experiences encountered during each rotation block.

Table 4-6 - Student Experience by Rotation Block ($\bar{X} \pm$ SD).

Experience Variable	Rotation Block Ending Date			
	1. Feb. 1994 (N=29)	2. May 1994 (N=29)	3. August 1994 (N=24)	4. Nov. 1994 (N=27)
Elective Histories	57.2 ± 34.19	54.38 ± 38.20	43.63 ± 18.80	48.78 ± 27.88
Elective Corrections*$^{\phi,\psi}$	11.55 ± 12.61	4.72 ± 8.51	3.83 ± 6.50	3.63 ± 6.61
Emergency Histories	8.55 ± 6.37	9.24 ± 7.16	12.17 ± 10.65	8.00 ± 6.18
Emergency Corrections	1.72 ± 2.80	2.52 ± 3.17	2.83 ± 3.10	1.93 ± 4.02
OR Scrubs	88.00 ± 41.07	88.48 ± 33.92	76.92 ± 36.25	67.63 ± 37.01
Procedures Done	11.31 ± 5.46	9.76 ± 5.02	9.83 ± 5.28	11.7 ± 8.55
OPD Clinics$^{\phi}$	10.93 ± 7.66	7.72 ± 8.46	5.38 ± 5.54	7.19 ± 5.79

* Feb. versus May $p \leq 0.05$
ϕ Feb. versus Aug. $p \leq 0.05$
ψ Feb. versus Nov. $p \leq 0.05$

ANOVA showed similar experiences between blocks except for elective corrections and OPD clinics. Students allocated to the block ending in February 1994 received more elective history feedback than students in subsequent rotations. Students assigned to the rotation ending in February 1994 attended more OPD clinics than August 1994.

Examination Performance by Rotation Block

Background Variables

Table 4-7 contains means and standard deviations for the background variables for each rotation block.

Table 4-7 - Background Variable Scores (%) by Rotation Block ($\bar{X} \pm$ SD).

Background Variable	Rotation Block Ending Date			
	1. Feb. 1994 (N=29)	2. May 1994 (N=29)	3. August 1994 (N=24)	4. Nov. 1994 (N=27)
SS	79.79 ± 4.36	80.01 ± 4.21	76.75 ± 6.17	78.22 ± 6.56
SC	75.78 ± 11.11	74.43 ± 9.94	70.13 ± 11.58	76.08 ± 7.97

ANOVA revealed similar rotation block scores. This suggests that students in each of the rotation blocks had similar surgical knowledge prior to the rotation.

Outcome Variables

Table 4-8 contains means and standard deviations for the outcome variable scores by rotation block. The KR-20 for the February and May MC was 0.71. The KR-20's for the August and November MC examinations were 0.51 and 0.48 respectively.

Table 4-8 - Outcome Variable Scores (%) by Rotation Block ($\bar{X} \pm$ SD).

	Rotation Block Ending Date			
Outcome Variable	**1. Feb. 1994**	**2. May 1994**	**3. Aug. 1994**	**4. Nov. 1994**
OSCE$^{*,\phi,\psi,\gamma,\infty}$	72 ± 5	84 ± 5	82 ± 3	76 ± 4
MC	70 ± 5	70 ± 5	70 ± 5	70 ± 5
rotation score$^{*,\psi,\infty}$	76 ± 5	81 ± 4	77 ± 6	82 ± 5

* Feb. versus May. $p \leq 0.05$
ϕ Feb. versus Aug. $p \leq 0.05$
ψ Feb. versus Nov. $p \leq 0.05$
θ May versus Aug. $p \leq 0.05$
γ May versus Nov. $p \leq 0.05$
∞ Aug. versus Nov. $p \leq 0.05$

ANOVA revealed students in rotation block 1 had lower OSCE scores than blocks 2, 3, and 4. Students in rotation block 4 had lower OSCE scores than either rotation 2 or 3. Students rotating in blocks 2 and 4 received more favorable rotation evaluations than block 1. Students in block 4 received higher rotation scores than block 3. The similarity of MC scores seen is a reflection of the process used to standardize examination scores for the two examinations used.

Table 4-9 presents means and standard deviations for the OSCE component scores by rotation block.

Table 4-9 - OSCE Breakdown (%) by Rotation Block ($\bar{X} \pm$ SD).

	Rotation Block Ending Date			
	1. Feb. 1994 (N=29)	**2. May 1994 (N=29)**	**3. Aug. 1994 (N=24)**	**4. Nov. 1994 (N=27)**
Mean Elective Station score$^{*,\phi,\gamma}$	74.65 ± 5.17	81.87 ± 3.60	79.94 ± 4.10	77.49 ± 3.94
Elective History Taking $^{\phi,\psi,\theta}$	73.69 ± 8.40	77.68 ± 7.73	84.82 ± 6.13	82.45 ± 7.57
Elective Physical Examination$^{*,\theta,\gamma}$	78.35 ± 9.39	87.53 ± 5.04	81.88 ± 5.57	79.37 ± 5.58
Elective Knowledge$^{*,\theta,\gamma}$	73.77 ± 6.32	80.24 ± 5.08	71.96 ± 7.28	71.44 ± 4.81
Mean Emergency Station Score$^{*,\theta}$	66.93 ± 7.37	74.79 ± 6.49	67.87 ± 5.51	71.48 ± 6.53
Emergency History Taking$^{\phi,\infty}$	56.30 ± 13.70	63.00 ± 13.15	67.81 ± 11.76	57.54 ± 9.23
Emergency Physical Examination$^{*,\phi,\psi,\gamma}$	71.16 ± 9.66	80.14 ± 8.74	80.63 ± 8.59	86.67 ± 8.20
Emergency Knowledge	79.72 ± 12.68	86.29 ± 10.19	83.44 ± 7.44	82.22 ± 9.84

* Feb. versus May. $p \leq 0.05$
ϕ Feb. versus Aug. $p \leq 0.05$
ψ Feb. versus Nov. $p \leq 0.05$
θ May versus Aug. $p \leq 0.05$
γ May versus Nov. $p \leq 0.05$
∞ Aug. versus Nov. $p \leq 0.05$

Significant differences were noted between rotation blocks for the various components of the OSCE. Students rotating in the first block had lower scores than subsequent rotations on the emergency physical examination component of the OSCE. They performed worse than students in the second block on the elective and emergency stations, elective and emergency physical examinations and elective knowledge. They performed worse than students in the third or fourth block on elective history taking.

Students rotating in the second block performed better than students in the third or fourth blocks on elective physical examinations and elective knowledge components of the OSCE. They

performed better than students in the third block on the emergency stations but worse on elective history taking. They performed better than students in the fourth block on the elective stations but worse on emergency physical examinations. Students in block 3 had higher emergency history taking scores than students in block 4.

Knowledge Gain Variable

The means and standard deviations for the comprehensive examination mark for each rotation block are summarized in Table 4-10.

Table 4-10 - Comprehensive Examination Mark (%) by Rotation Block ($\bar{X} \pm$ SD).

	Rotation Block Ending Date			
	1. Feb. 1994	**2. May 1994**	**3. August 1994**	**4. Nov. 1994**
Comp.	69.49 ± 7.19	71.68 ±7.65	71.05 ± 8.96	70.21 ± 8.84

ANOVA revealed no differences between rotation blocks.

High versus Low Volume Experience

The following data address the fourth purpose of the thesis: to determine if the volume and type of experience offered during the surgical clerkship was related to the students' performance on their exit examinations. This was done using two methods. First, examination scores were compared between students with a high volume (top 1/3) compared to a low volume (bottom 1/3) of each experience variable. Using this method it was possible to determine which experiences benefited, which were detrimental, and which had no effect on examination scores. Second, using regression analysis it was possible to determine which experiences increased the correlation between the background variables and the outcome variables.

Table 4-11 presents means and standard deviations of the background and outcome variable scores for students with high numbers of clerkship experiences and students with low numbers of clerkship experiences.

Table 4-11 - Comparison of Performance Variable Scores Between Students With High Volume (top 1/3) versus Low Volume (bottom 1/3) Experiences ($\bar{x} \pm$ SD).

			Background Variables		Outcome Variables		
Experience Variable		**N**	**SS**	**SC**	**MC**	**OSCE**	**Rotation**
Elective Admissions	**High**	**37**	78.84 ± 5.34	74.10 ± 10.17	70.21 ± 4.70	77.66 ± 6.49	79.73 ± 5.45
	Low	**36**	79.28 ± 5.73	73.03 ± 10.61	70.00 ± 5.47	78.43 ± 6.66	78.39 ± 6.18
Emergency Admissions	**High**	**41**	78.80 ± 5.56	73.62 ± 11.43	70.63 ± 5.21	79.78 ± 5.86*	79.34 ± 5.79
	Low	**40**	78.53 ± 5.10	73.96 ± 11.27	69.56 ± 5.16	76.98 ± 6.23*	78.20 ± 5.93
Corrected Electives	**High**	**38**	79.34 ± 4.31	74.71 ± 6.63	70.18 ± 5.00	77.08 ± 6.80	78.37 ±6.04
	Low	**39**	78.33 ± 5.22	73.44 ± 9.16	70.57 ± 4.94	79.63 ± 6.63	79.64 ± 5.12
Corrected Emergencies	**High**	**45**	78.93 ± 5.71	73.75 ± 11.23	70.47 ± 4.83	80.07 ± 6.43*	78.98 ± 5.45
	Low	**57**	78.74 ± 5.39	74.71 ± 10.26	69.95 ± 5.29	77.01 ± 6.23*	79.28 ± 5.96
OR Scrubs	**High**	**36**	79.61 ± 4.93	76.39 ± 10.73	70.15 ± 5.43	78.34 ± 6.32	80.14 ± 5.46
	Low	**36**	78.42 ± 6.19	73.11 ± 9.45	70.20 ± 5.43	78.06 ± 6.45	78.08 ± 5.56
Procedures	**High**	**43**	79.30 ± 5.18	74.80 ± 9.96	70.03 ± 4.99	77.33 ± 6.14	79.53 ± 5.73
	Low	**39**	77.72 ± 6.19	74.40 ± 8.73	69.36 ± 4.50	77.84 ± 7.01	79.02 ± 5.54
OPD Clinics	**High**	**40**	79.70 ± 5.16	76.67 ± 8.83*	71.08 ± 5.03	77.03 ± 6.06*	79.33 ± 5.39
	Low	**39**	77.45 ± 5.57	71.01 ± 9.83*	70.18 ± 4.54	80.26 ± 6.47*	79.60 ± 5.28

* $p \leq 0.05$

The information presented in Table 4-11 demonstrates that for the majority of performance variables there was no difference in mean scores between students having a high volume experience and those having a low volume experience. There were a few notable exceptions. Students who attended more OPD clinics performed less satisfactorily on the OSCE than those attending fewer OPD clinics. This was made more alarming by the fact those students attending more OPD clinics tended to have more pre-rotation surgical ability as estimated by the background variables (supp. surg. p=0.065 and surg. comp. p=0.05).

Also of note, there was no significant difference in OSCE scores for students with high versus low volume elective corrections. However, students with more elective corrections tended to perform less satisfactorily on the OSCE than those with fewer elective history corrections (p=0.06). Analysis of emergency histories and feedback revealed that those students with higher volume

emergency experience and feedback on emergency histories performed better on the OSCE. Thus higher numbers of OPD clinics appeared to be detrimental to OSCE scores and emergency histories and feedback appeared to be beneficial to OSCE scores.

Table 4-12 presents comp. score means and standard deviations for students with high numbers of clerkship experiences and students with low numbers of clerkship experiences.

Table 4-12 - Comparison of Comprehensive Examination Scores Between Students With High Volume (top 1/3) versus Low Volume (bottom 1/3) Experiences ($\overline{X} \pm$ SD).

			Knowledge Retention Variable
Experience Variable		**N**	**Comprehensive**
Elective Admissions	**High**	**37**	70.98 ± 8.43
	Low	**36**	71.33 ± 7.66
Emergency Admissions	**High**	**41**	70.95 ± 6.99
	Low	**40**	70.39 ± 7.61
Corrected Electives	**High**	**38**	70.04 ± 7.52
	Low	**39**	70.28 ± 8.78
Corrected Emergencies	**High**	**45**	71.48 ± 8.70
	Low	**57**	70.19 ± 7.58
OR Scrubs	**High**	**36**	69.98 ± 7.56
	Low	**36**	70.91 ± 8.50
Procedures	**High**	**43**	71.19 ± 7.82
	Low	**39**	69.90 ± 9.25
OPD Clinics	**High**	**40**	71.60 ± 7.58
	Low	**39**	69.71 ± 7.77

Analysis of the data presented in Table 4-12 revealed no significant difference in comprehensive examination scores between students with high versus low volume of each of the experience variables. Thus none of the experiences seemed to improve student surgical knowledge retention.

A similar analysis was carried out for each of the components of the OSCE (Table 4-13 and Table 4-14). These tables present means and standard deviations for each of the OSCE component scores for students with high numbers of each clerkship experience and low numbers of each experience.

Table 4-13 - Comparison of Elective OSCE Component Scores Between Students With High Volume (top 1/3) versus Low Volume (bottom 1/3) Experiences ($\bar{X} \pm$ SD).

			Elective Station Component of OSCE			
Experience		**N**	**Stations**	**Histories**	**Physicals**	**Knowledge**
Elective Admissions	**High**	**37**	77.69 ± 5.46	78.96 ± 9.19	79.82 ± 8.06	73.66 ± 7.70
	Low	**36**	78.94 ± 5.28	79.46 ± 10.30	82.37 ± 7.04	76.14 ± 6.27
Emergency Admissions	**High**	**39**	79.27 ± 4.81	80.05 ± 8.20	82.06 ± 7.62	75.75 ± 7.03*
	Low	**40**	77.81 ± 4.58	80.18 ± 8.76	80.93 ± 7.99	72.33 ± 6.27*
Elect. Corrections	**High**	**38**	77.61 ± 5.07	78.32 ± 8.88	80.83 ± 7.71	74.29 ± 5.95
	Low	**37**	79.65 ± 5.18	81.37 ± 7.88	83.37 ± 7.16	75.00 ± 7.51
Emergency Corrections	**High**	**43**	79.33 ± 5.38	79.82 ± 8.57	82.52 ± 7.22	75.91 ± 7.15
	Low	**57**	77.58 ± 4.73	78.86 ± 9.02	81.10 ± 7.85	73.34 ± 6.54
OR Scrubs	**High**	**36**	78.36 ± 5.63	78.82 ± 8.57	81.19 ± 8.72	74.78 ± 6.87
	Low	**36**	78.50 ± 4.22	80.60 ± 7.37	81.77 ± 6.39	73.51 ± 6.07
Procedures	**High**	**43**	77.29 ± 4.95	78.49 ± 9.16	80.15 ± 7.95	74.02 ± 6.22
	Low	**37**	78.40 ± 5.26	79.56 ± 9.53	82.60 ± 7.48	73.76 ± 6.84
OPD	**High**	**40**	77.28 ± 5.24*	77.42 ± 8.32	81.64 ± 7.80	74.28 ± 6.23
	Low	**39**	80.06 ± 4.84*	80.73 ± 7.99	82.93 ± 7.13	75.70 ± 8.06

* $P \leq 0.05$

There were no significant differences in OSCE component scores between students with a high volume versus low volume of each of the experience variables except for emergency admissions and OPD experience. Students with high numbers of emergency admissions scored higher on the elective knowledge testing component of the OSCE. Students with more OPD clinic experiences had lower scores on the elective surgery OSCE stations than students with fewer OPD experiences. In addition, students with a higher volume of emergency history corrections tended to have higher scores on the elective knowledge testing component of the OSCE ($p=0.06$) than students with fewer elective history corrections.

Table 4-14 - Comparison of Emergency OSCE Component Scores Between Students With High Volume (top 1/3) versus Low Volume (bottom 1/3) Experiences ($\bar{X} \pm$ SD).

			Emergency Station Component of OSCE			
Experience		**N**	**Stations**	**Histories**	**Physicals**	**Knowledge**
Elective admissions	**High**	37	70.00 ± 7.51	59.68 ± 15.27	79.35 ± 10.55	81.01 ± 12.85
	Low	36	70.11 ± 7.07	60.20 ± 12.25	79.08 ± 10.57	84.79 ± 6.45
Emergency Admissions	**High**	39	71.07 ± 7.11	63.45 ± 12.65	79.64 ± 10.91	83.91 ± 7.02
	Low	40	69.04 ± 7.32	61.44 ± 13.38	79.08 ± 10.97	79.88 ± 13.47
Elective Corrections	**High**	38	69.33 ± 7.55	58.05 ± 11.84	77.06 ± 11.05	82.04 ± 12.11
	Low	37	70.90 ± 7.12	63.86 ± 13.63	80.91 ± 10.18	82.30 ± 11.03
Emergency Corrections	**High**	43	71.80 ± 7.94	64.35 ± 11.68*	81.22 ± 9.55	84.53 ± 9.48
	Low	57	69.21 ± 6.67	58.84 ± 12.83*	77.77 ± 11.09	81.45 ± 11.23
OR Scrubs	**High**	36	70.25 ± 6.77	59.48 ± 12.17	79.84 ± 9.17	82.22 ± 11.93
	Low	36	70.32 ± 7.59	62.03 ± 13.07	79.51 ± 11.07	82.64 ± 11.05
Procedures	**High**	43	70.76 ±6.94	59.94 ± 11.90	79.58 ± 11.24	82.97 ± 11.13
	Low	37	69.80 ± 7.06	61.03 ± 14.75	79.15 ± 10.08	81.42 ± 11.40
OPD	**High**	40	70.82 ± 6.93	59.16 ± 12.36	79.74 ± 9.72	83.56 ± 8.04
	Low	39	71.17 ± 7.99	63.28 ± 14.10	79.86 ± 10.05	82.50 ± 11.96

* $p \leq 0.05$

Students with higher numbers of emergency admission corrections had higher emergency history scores than those with fewer corrections. In addition, students with higher numbers of elective admission corrections tended to have lower emergency history scores on the OSCE than those with fewer corrections ($p=0.052$).

In summary, outpatient clinics seemed to impact negatively on mean OSCE and select OSCE component scores. Emergency admissions and corrections appeared to impact favorably on these scores. Elective history corrections tended to impact negatively on the OSCE and but this result did not reach statistical significance.

The results of the regression analysis follow.

Regression Analysis

For this study, regression analysis allowed the determination of the amount of variability in outcome and knowledge retention variable (exit examination) scores that was attributable to variation in experience. By forcing the background variable scores into the regression analysis first, it was possible to partial out the role of variation in background variable scores in determining variation in exit examination scores. Thus by inserting each of the experiences into the analysis in a stepwise fashion, those experiences that accounted for a significant proportion of the variability in exit examination scores could be identified. Using this technique, the role of pre-rotation surgical knowledge in determining examination scores could be controlled for and those experiences having a role in determining exit examination performance could be identified.

Multiple correlations between background variables and OSCE, MC, rotation score and comprehensive examination were 0.136, 0.359, 0.267 and 0.064 respectively. None of the experience variables contributed to the gain in correlation between background and MC, rotation scores or comprehensive examination score. The same was true of the OSCE with two notable exceptions. Addition of corrected elective histories increased the correlation from 0.136 to 0.279. However the relationship was in a negative direction (β = -0.244). Addition of corrected emergency histories increased the correlation from 0.237 to 0.365. This relationship was in a positive direction (β = 0.237).

The regression analysis was repeated in a similar fashion with each of the OSCE components as the dependent variables. The majority of experience variables did not increase the correlation between background and OSCE components. There were a few notable exceptions. For the elective surgery station scores, the addition of OPD clinics increased the correlation from 0.244 to 0.333. This relationship was in a negative direction (β = - 0.233). Addition of corrected elective histories further increased the correlation to 0.382. This relationship was in a negative

direction (β = - 0.187) For the elective knowledge testing scores, addition of emergency admissions increased the correlation from 0.293 to 0.361. This relationship was in a positive direction (β = 0.212). For the emergency station scores, addition of corrected emergency admissions increased the correlation from 0.059 to 0.205. This relationship was in a positive direction (β =0.198). For the emergency physical examination scores, addition of corrected emergency admissions increased the correlation from 0.086 to 0.211 in a positive direction (β = 0.194). Addition of corrected elective admissions further increased the correlation to 0.288 in a negative direction (β = -0.196).

According to the regression model, elective history corrections impacted negatively and corrected emergency histories impacted positively on mean OSCE scores. OPD experience and elective history corrections impacted negatively on various components of the OSCE. Emergency histories and corrections of these histories impacted positively on various components of the OSCE.

Summary

The results appear to indicate marked variation in experience both between and within hospitals. However, no difference in mean examination scores was obtained between hospitals. Student pre-rotation knowledge was similar both between hospitals and between rotation blocks. Experience offered students during each of the rotation blocks was essentially similar. Despite similar pre-rotation knowledge and rotation experience, student rotation block scores were not similar.

The majority of clinical experiences appeared to have no impact on student performance on exit examinations. Those that did impact performance did so either in a positive or a negative fashion. The next chapter presents the discussion of these results.

Chapter 5

Discussion

The intention of this study was to determine if: 1) student rotation experiences were similar between clerkship sites, 2) student performance on surgical examinations was similar between teaching sites, 3) experience gained from previous rotations impacted examination performance, and 4) the volume and type of experience offered during the surgical clerkship was related to the students' performance on their exit examinations.

This study demonstrated large differences in clerkship experience at the hospitals studied. The infrequent quantity of history feedback is consistent with previous research results.[12,33,41] Despite this variation in experience, student surgery examination scores were similar. Thus, after demonstrating similar student pre-rotation knowledge, large variation in experience offered at the affiliated teaching hospitals resulted in no difference in student post-rotation surgical knowledge and student surgical knowledge retention.

When determining if previous rotation experience influenced surgery examination scores, it was important to note if differences existed in students' background knowledge and the experience offered during the rotation block. Block analysis of background variables suggested similar student ability between rotation blocks. The volume of clinical experiences offered students was similar between rotation blocks except for elective history feedback and OPD clinics. Students in the first rotation received more elective history feedback than students in subsequent rotations and attended more OPD clinics than the third rotation. Thus the students in each rotation were essentially similar except for their stage of training when they rotated through surgery.

For the OSCE, students in the first rotation had lower scores than subsequent rotations, suggesting a disadvantage for those students with less experience. Of note, OPD and corrected elective histories were the two types of experiences that impacted negatively on OSCE scores. Perhaps students in the first block were at a disadvantage on the OSCE as a result of increased numbers of these experiences. The improvement in examination scores seen in the second and third rotation block suggested that clerkship experience gained during previous rotations was advantageous. However, the students in the final rotation block had lower scores than the second or third block.

When the OSCE stations were analyzed by component, several differences between rotation blocks were noted. Students in the first rotation block had lower scores than one or more of the subsequent rotations on all the components of the OSCE except for the emergency knowledge testing component. This again suggests a disadvantage for inexperienced students. The lack of discernible pattern for the remainder of the rotation block differences precludes drawing meaningful conclusions about the role of rotation experience in determining OSCE component scores. However, a significant trend emerged. It appeared that as students progressed through their training, their ability to perform physical examinations on patients with emergent surgical problems improved. Perhaps previous clerkship rotation experience had a role in this trend.

Rotation scores in the second and third block were significantly higher than either the first or fourth block. Again this suggests that experience gained through other rotations reflects positively on their evaluations. This conclusion is weakened by the lower rotation scores seen in the fourth block. Students in all blocks scored similarly on the final comprehensive examination. Thus students who rotated through surgery earlier did not have any appreciable knowledge decay when compared to students in later rotations. The findings of this study suggest but do not conclusively show that more experienced students perform better on surgery exit examinations.

This study showed that numbers of OR scrubs, elective admissions and ward procedures appeared to have no direct effect on outcome scores. However, emergency admissions, feedback on elective and emergency histories and OPD experience did impact OSCE scores.

Students with higher numbers of emergency admissions and corrections scored higher on the OSCE. This was notable for the elective knowledge and emergency physical examination components of the OSCE. Addition of corrected emergency histories increased the correlation between background and OSCE with a positive β suggesting that after background knowledge was taken into account, higher numbers of emergency corrections were associated with higher OSCE scores. In addition, emergency admission corrections improved the correlation between background variables and the emergency station or emergency physical examination scores with a positive β suggesting the higher numbers of emergency corrections was associated with higher scores on these OSCE components. Emergency admissions increased the correlation between background and the elective knowledge testing component of the OSCE, suggesting that after the role of background variables in determining elective knowledge testing scores was taking into account, increased emergency admissions were associated with higher elective knowledge testing scores.

These findings suggest that emergency experience and feedback are beneficial to student performance on the OSCE. Specifically, it would appear that emergency room experiences and feedback improve elective surgical knowledge, as well as student ability to perform emergency histories and physical examinations.

In contrast to this, addition of elective history feedback increased the correlation between background variables and the OSCE with a negative β suggesting that after accounting for the role of background knowledge in determining OSCE scores, higher numbers of elective history corrections resulted in lower OSCE scores. Further, addition of corrected elective histories increased the correlation between background and the elective surgery or emergency physical examination scores, both with negative β's suggesting that after background knowledge was accounted for, more elective history corrections resulted in lower scores on these components of the OSCE. Students with high

volume elective history feedback tended to have lower mean scores on the OSCE as well as lower mean scores on the emergency history component of the OSCE.

These results suggest that elective history corrections were detrimental to student performance on the OSCE. However, one problem arises. The students with the highest mean number of elective history corrections rotated in the first block and thus were the first to take the OSCE. Closer analysis of the data revealed that 18 of 38 students with a high volume of elective history corrections rotated in the first block. This compares to 4 of 37 who rotated in the first block and were deemed to have low volume elective history feedback. If students rotating in the first block were at a disadvantage on the OSCE strictly as a result of rotation timing, the results of the high versus low volume analysis and the regression analysis of elective corrections may be biased by the influence of the timing of the rotation.

If, however, the students were at a disadvantage on the OSCE as a result of having higher numbers of elective history corrections, the following question arises: what is the difference between emergency and elective feedback that makes one beneficial and one detrimental? As described in the methods section, it was relatively easy to compile data on the quantity of experience. However, the quality of experience is much more difficult to determine. It is the author's belief that the difference between the two lies in the quality of the feedback.

Several problems arose from the method of feedback outlined for elective admissions. First, the quantity of feedback relied heavily on student initiative and ability to follow-up their assessments. Second, feedback, when it occurred, was at a time remote from the assessment. Thus assessment strengths or weakness were not immediately reinforced nor corrected. Third, reading, correcting and signing the histories may not be as beneficial a method of feedback as the immediate one-on-one method outlined for emergency admissions.

It can be assumed that the students who received the first method of feedback noted their history was signed and assumed their assessment was correct. They then were less inclined to pursue further study to improve their technique. While many other factors may play a role, this data

suggests that periodic low quality feedback is detrimental to student learning. These results and their explanation require further study. As a result, the logbooks have been altered to better determine the method of feedback.

Students with higher numbers of outpatient clinic had lower OSCE scores. This finding was evident for the elective stations of the OSCE. Increased numbers of OPD experience increased the correlation between background and the OSCE elective stations with a negative β. This suggests that after background knowledge was accounted for, increased OPD experience was associated with lower elective station scores.

The same problem that arose for elective history corrections was encountered with OPD experience. Students with the highest mean numbers of OPD experiences also rotated in the first block (only reaching statistical significance against students in the third block) . Closer analysis of the data revealed that 15 of the 40 students considered to have high numbers of OPD experiences rotated in the first block. Also, 5 of the 39 with low numbers of OPD experiences rotated in the first block. Again the influence of rotation timing, and thus timing of the OSCE, may bias the high versus low and regression analysis results for OPD experience.

If the students were at a disadvantage because of higher numbers of these experiences, this may be due to the nature of the OPD experience. OPD clinics require timely, efficient assessment and diagnosis of surgical patients. The surgical staff examine patients based on their knowledge and experience and thus are able to effectively truncate their assessments, obtaining a focused history based on relevant questions important for that particular problem. The student does not have the advantage of experience and thus may not be able to follow the reasoning behind these shortened histories and physical examinations. Thus while observing efficient, abbreviated assessments, the student may have been learning examination techniques insufficient for scoring well on the OSCE.

The above results have prompted reassessment of elective history and feedback experience as well as the outpatient experience offered students. The pre-admission clinic is being de-emphasized. Cost cutting measures are resulting in increasing numbers of pre-operative histories and

physical examinations being completed in the physicians' offices. Thus patients are bypassing the pre-admission clinic and fewer patients are available for students to assess. In order to alleviate this problem, several of the surgeons have improved the students' outpatient or office experience by setting aside "new" patients strictly for student assessment. Students are then able to conduct full histories and physical examinations on these patients. Because these assessments occur in the surgeons' office, provision for immediate one-on-one feedback can be made. This solution would appear to address weaknesses in outpatient experience, elective history experience and elective feedback.

Previous work at our institution demonstrated relatively poor compliance with logbook completion and return.[41] By orienting the students to proper logbook entry and requiring them to return completed logbooks in order to receive a rotation mark, compliance increased from 64% to 96%. In order for the clinical experience to be considered valid, the students were required to document the patient's unique identifier number after each patient contact. This made fabrication of patient contacts less likely. This coupled with the increased rate of logbook return, suggested good compliance with logbook completion.

In summary, the results of this study confirm previous studies that show significant variation in surgical clerkship experience between hospitals affiliated with a teaching program. Despite the variation in experience, students who had similar background knowledge in surgery performed similarly on end-of rotation examinations. However, the present study expands on previous observations by showing that the number of emergency admissions and feedback was beneficial to student performance on the OSCE and higher numbers of elective history corrections and outpatient experiences correlated negatively with OSCE. The volume of OR scrubs, elective histories and procedures done had no impact on examination performance. Increased surgical clerkship experience did not appear to improve surgical knowledge retention. The role of previous clerkship experience in determining exit examination scores remains unclear.

The results of this study have raised several questions and have demonstrated the need for further study. These issues will be discussed in the following chapter.

Chapter 6

Future Study

The results of this study raise several questions. Are the logbooks capturing the appropriate information? What is the best method of feedback? How can the clerkship be modified to improve surgical education? Are we measuring the right clerkship knowledge and skill attributes with our examinations? Do students with higher volume experience make better physicians? What is the role of experience in encouraging long-term retention of surgical principles?

Students learn surgery through diverse methods. Our study analyzed only one of the methods used, the role of clerkship clinical experience. Thus, what is the role of the other methods of learning such as independent study, teaching sessions and seminars, and preceptor bedside teaching in determining knowledge gained during the rotation. Further, do students who have "slower" rotations have more time to study as suggested by Schwartz et. al.? [18] Does increased reading time compensate for decreased experience? These questions may be further addressed by modifying the logbooks, the clerkship, the assessments used and by further study.

Logbooks

This study identified major weaknesses in the current design of the logbooks. The logbooks made no provision for recording the method of feedback nor was an attempt made to record self-directed learning.

As feedback appeared to contribute significantly to clerkship education, the new logbooks contain forms that allow students to record the method of feedback received for each assessment. Students are now expected to record if the history was signed, corrected and signed or whether the student received one-on-one feedback. The analysis used for this thesis can easily be applied to

further resolve the role of quality of feedback in determining examination performance. Once the role of feedback quality is determined, methods to improve feedback techniques can be trialed.

In order to determine the impact of self-directed learning on clerkship education, the class of 1996 are using logbooks that have forms for recording time spent studying and reading around patients. One would predict low student compliance with recording this information due to 1) the labor intensive nature of recording every facet of study time, 2) the reluctance of any student to admit they seldom study, resulting in increased incentive to fabricate study time. Despite these reservations, the role of student initiative and study habits in determining examination scores may be determined using information recorded in the changed logbooks.

Clerkship Design

After completing this study, health care funding reductions have necessitated modifications to the clerkship. Two city hospitals have been converted to community health centres. Patients admitted to these hospitals are admitted exclusively for day surgery or short stay surgery. Patients requiring major surgery are now admitted to the two tertiary care centres. These changes will likely result in even more dramatic differences in the experience offered students during their rotations. The impact of these changes on clerkship education will need to be determined.

Further, the rotation has been shortened to 8 weeks. This, in addition to changes in the way patients are admitted to hospital and changes to OPD experience as outlined on page 61, will further affect the nature of the clerkship. The educational impact of these altered experiences requires further study. Surgical educators must constantly seek ways to improve clerkship experience including providing opportunity for practicing various techniques and feedback on the adequacy of the students' technique.

As education, inpatient and staff surgeon resources continue to dwindle, less time will be available for high quality one-on-one feedback. Alternative methods must be found and tested. One

such method may be the increased use of computers to provide students with an interactive feedback-oriented tutorial.

The advantages of computer-assisted instruction are obvious. The tutorials, if well designed, can be highly complex, interactive and enjoyable learning tools. The computer is essentially always available, is never tired and can offer entirely objective feedback. Computers are growing rapidly both in terms of capability as well as availability. One can readily foresee this resource playing a much larger role in student education in the future.

Finally, continuous change in the nature of the surgical clerkship has likely made current rotation objectives outdated. These should be reviewed and updated by a panel of surgeons.

Assessments

Each of the examinations used to assess student knowledge of surgical principles should be re-evaluated.

Multiple Choice Examination

Analysis of the scores obtained by students writing the multiple choice examination raised two concerns: 1) students writing one examination had lower mean scores than those writing the other examination, 2) the examination with lower mean scores had lower reliability than the other examination.

These examinations should be re-evaluated. Ideally each item on the examinations should be analyzed separately by a panel of physicians with input from the Division of Studies in Medical Education. Each item could then be assessed for how well it tests knowledge of surgical principles, as outlined in the rotation objectives. Unclear, ambiguous or otherwise faulty items could be excluded or modified, thus improving the reliability and validity of the examination.

The reliability of the OSCE was found to be somewhat low. Further work needs to be done to improve the reliability of this examination. This could be addressed by re-evaluating the examination, lessening OSCE observer and patient variability, lessening variability in student OSCE taking methods.

A panel of physicians should analyze each of the standardized checklists, thus ensuring that the history, physical and knowledge testing checklists are appropriate for each station. Further, as the examination requires observation and scoring by surgeons, a certain amount of observer variability likely contributes to the lack of reliability. This could be addressed as follows. Observer variability could be lessened by using the same observers for the same stations for each examination. As recruiting willing volunteers for this task may be somewhat difficult, the next option may be more feasible. The observers must be explicitly instructed as to how to appropriately conduct and score an OSCE examination. This may take the form of a more in depth pre-examination orientation for the observers, including individual tutoring for each station. In addition faculty wide OSCE workshops dealing with how to appropriately conduct an OSCE could be presented once or twice a year.

In order to minimize the variability in OSCE "patients" the same actors/patients should be present for each examination. As this is often not possible, each patient must be put through a training session and given study material to teach them the appropriate responses to the students' queries. This method is currently in use at the University of Alberta for the surgery OSCE.

OSCE performance relies to a certain extent on the student's familiarity with the method of taking the OSCE. Students often forget that they are to treat the trained "patients" as real patients. They tend to verbalize rather than perform the assessment and may lose marks in the process. Some have a tendency to become side-tracked, pursuing too broad a line of questioning. As performance on the OSCE depends largely on a focused yet complete history, those who become sidetracked run out of time before all appropriate history and physical examination components are completed. Thus, students well tutored in OSCE taking methods are likely more aware of how to properly take

an OSCE, lessening their chances of making the above mistakes. These students may be at an advantage over those less well tutored. This problem may be addressed by conducting a short course in OSCE methods for the students at the end of their second medical school year. Techniques learned during this course could be reinforced during the pre-OSCE orientation.

Studies to Further Assess the Role of Clerkship Experience in Student Knowledge Gain and Retention

One possible study to further address the impact of clerkship experience on clerkship knowledge gain and retention could be designed as follows. The students from an entire academic year would undergo a pre-rotation MC and OSCE. They would then record rotation experiences in the modified logbook (as described above). At the end of the rotation, they would then take a MC and OSCE examination. At the end of their medical-school training, another MC and OSCE would be taken. Scores on these examinations could be then used to determine pre-rotation surgical knowledge, post-rotation surgical knowledge and post-rotation knowledge retention respectively.

Further information could be obtained by using the students' scores on the Medical Council of Canada (MCC) qualifying examination.[42] The part I examination consists of four parts. Parts one through three consist of about 450 multiple choice items across six medical disciplines. Part four consist of clinical decision making items based on the concept of key features. The questions pertaining to surgery could be used in a similar analysis to the comprehensive examinations used in this study. Part II of the MCC qualifying examination is an OSCE. The student's scores on the MCC qualifying examination could be analyzed to determine if long term knowledge retention and knowledge of clinical assessment techniques improve with increased clerkship experience. Using a study design similar to this one, further answers about the benefit of clerkship experiences may be obtained.

Health care and education funding in Alberta are currently undergoing phenomenal change. This change will inevitably alter the way medical students are trained. The impact of these changes

on clerkship training will need to be monitored closely. Logbook and examination performance data as modeled in this thesis will be an integral part of this assessment process.

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Appendix A

FACULTY OF MEDICINE - UNIVERSITY OF ALBERTA
PHASE III STUDENT INTERN EVALUATION FORM

Return to

STUDENT NAME: YEAR OF GRADUATION: 1996

PRECEPTOR: ROTATION: HOSPITAL:

DATES OF ROTATION:

This evaluation form was done after a discussion with nurses, residents, and other staff, and is not just a direct reflection of the preceptor.

1.) SUBJECTIVE ASSESSMENT CATEGORIES

HOW DOES THIS STUDENT COMPARE WITH OTHER STUDENTS AT THE SAME LEVEL OF TRAINING?

Unable to evaluate	Inadequate performance	Below average	As expected for this level	Above average	Outstanding performance
___	___	___	___	___	___

NOTE: PLEASE CAREFULLY READ AND USE THESE DEFINITIONS FOR THE SUBJECTIVE ASSESSMENT

90-100%	Greatly exceeds performance expectations for a student intern with this level of training.
80-89%	Consistently exceeds performance expectations for a student intern with this level of training.
75-79%	Capable, hard-working student who often exceeds performance expectations.
65-74%	AVERAGE STUDENT. Expected levels of performance and knowledge.
55-64%	Students with obvious but minor deficiencies that should be remedied with time.
50-54%	MARGINAL. Will require remedial work.
less than 50%	Does not meet accepted standards of performance. Major deficiencies requiring repetition of rotation.

Patient Assessment and Care:

History and physical examination	___	Reliability and work attitude	___
Patient assessment with interpretation of findings	___	Interpersonal relationships with patient, family and staff	___
Formulation of investigation and treatment plan	___	Fund of knowledge appropriate to level of training	___
Selection and interpretation of laboratory studies	___	Application and use of written record	___
Patient management and continuing care	___	Procedural skills	___
		Other	___

Professional Attitudes and Abilities:

OVERALL SUBJECTIVE ASSESSMENT GRADE: _____ (Use Percentages as defined above) _____ Weight

2.) OBJECTIVE ASSESSMENT CATEGORIES (Use percentages)

	GRADE	WEIGHT
Oral examination	_____	_____
Written examination	_____	_____
O.S.C.E.	_____	_____
Other (*specify*)(_____)	_____	_____

OVERALL OBJECTIVE ASSESSMENT GRADE: _____ (Use Percentages) _____ Weight

FINAL GRADE (Composite of Subjective and Objective Assessments) _____ (Use Percentages)

(A pass mark is required for both Subjective and Objective Assessments)

GENERAL COMMENTS (Please type or print or write very legibly. These comments are used for Dean's reference letters)

COMMENTS FOR COUNSELLING STUDENT IMPROVEMENT:(Will not be included in Dean's Letter)

STUDENT'S COMMENTS (on the evaluation):

I acknowledge this evaluation has been discussed with me

(DATE)
Signature of Student Intern

Name of Preceptor (please print)

(DATE)
Signature of Preceptor

(DATE)
Signature of Hospital Coordinator

(DATE)
Signature of Rotation Coordinator
(Coordinator: Please duplicate this evaluation for your files)

I:\c:\docs\rotation\eval.doc